Space Weather Technical Forecast

Issued on Friday, 28 July 2023 at 01:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily chance of R1/R2 radio blackouts. Slight chance of Minor Storm (G1) Day 4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours with an M1.9 observed at 27/0951UTC from AR3376. A long duration M1.7 was also observed around 27/2235UTC from AR3388. There are currently up to 10 sunspot regions on the visible disc. The largest and most active region remains AR3376 however it has now rotated over to the far side and has been removed from the count. There are other large regions but they appear stable and largely inactive. Two regions are however turning increasingly large and complex, namely AR3380 and AR3386, with proliferation of spots, some of which display a rudimentary penumbra.

A small filament was observed lifting off the sun around 27/1330UTC, in the southwest quadrant, leading to a faint CME. The results of the analysis are pending but given its location and estimated velocity, it may give Earth a slight glancing blow in the early UTC hours of Day 4 (31st). No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, measured at L1, most likely remained influenced by the combination of the fading effects of the CME that arrived at Earth on 25 July and a weak connection with the high speed stream originating from CH28/+. The solar wind declined from 510 to 410 km/s but its declining trend became more slow during the second half of the period, remaining slightly elevated. Density has been around average, between 6-10ppcc. Total magnetic field strength, Bt has been weak but steady, around 7nT. The north-south component, Bz, fluctuated weakly between +5nT and -2nT although it remained mostly in a positive orientation. Phi angle was positive (away from the sun) throughout. This resulted in a Quiet geomagnetic activity (Kp 0-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels. GOES16 high energy (greater than 2MeV) electron flux oscillated between background to moderate throughout. The associated 24-hour integrated fluence was well below the Active threshold on a steady trend. Fluence was 1.54e7 integrated pfu at 28/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast, with a slight chance of X-flares, most likely from AR3376.

Solar Wind / Geomagnetic Activity: A CME which left the southwest quadrant of the sun on 27 July may give Earth a glancing blow on Day 4. However confidence is low. No other CMEs feature in this forecast. Solar winds are currently under the weak influence of CH28 but expected to slowly decline towards background levels, with no further enhancement expected.

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Met Office Space Weather Technical Forecast

Geomagnetic activity is expected to be mostly Quiet to Unsettled, but Unsettled to Active with a slight chance of Minor Storm intervals (G1) on Day 4 (31st).

Energetic Particles / Solar Radiation: There remains a slight chance of the high energy (greater than 10MeV) proton flux increasing from any further significant flares that occur. This risk reduces a little through the period as AR3376 rotates across the northwest limb. The high energy (greater than 2MeV) electron flux is likely to rise as wind speeds ease, but the associated fluence is forecast to remain below the Active (1e8 integrated pfu) threshold during this period.

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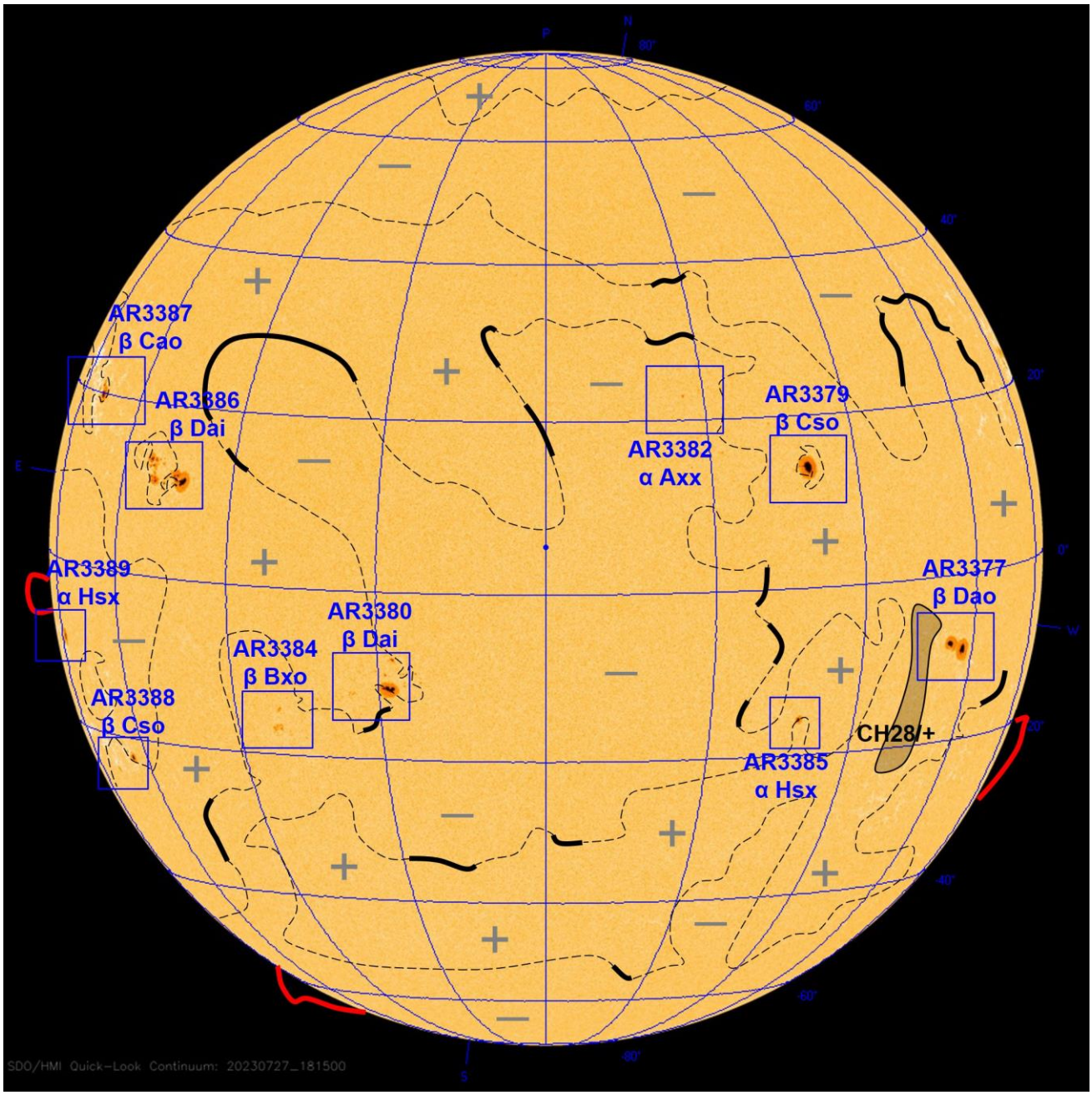
Figure 1. Solar Analysis Valid 27/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the southwest quadrant of the sun on 27 July may give Earth a glancing blow on Day 4. However confidence is low given the results of the analysis are still pending. No other Earth-directed CMEs were observed during the period.

During the last 24 hours the Earth appears to have transitioned from the magnetic cloud associated to the CME that arrived on 25 July to the weak HSS originating from CH28/+. In the absence of significant coronal hole on the western hemisphere, the solar wind is expected to slowly decline and return to background levels until the potential arrival of the CME. Geomagnetic activity is expected to be mostly Quiet to Unsettled, but Unsettled to Active with a slight chance of Minor Storm intervals (G1) on Day 4 (31st).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Awaiting results of the analysis - Low confidence

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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate over the past 24 hours with an M1.9 observed at 27/0951UTC from AR3376. A long duration M1.7 was also observed around 27/2235UTC from AR3388 (in the southeast quadrant).

There are 11 sunspot regions classified on the visible disc. The largest and most active region remains AR3376 however it has now rotated onto the far side and has been removed from the tables. AR3380 has grown in size and complexity, with the addition of two spots with rudimentary penumbra on its northern flank. AR3386 is also turning increasingly large and complex, with proliferation of spots in its intermediate section, some of which display a rudimentary penumbra. AR3387 remains unchanged but reveals a large plage as it continues to rotate further onto the northeast limb. The two new regions in the southeast quadrant have now been numbered, respectively AR3388 and AR3389. AR3386 consists of a couple of spots and a large plage, whereas AR3389 may reveal further spots as continues to rotate further. All other regions are small and stable.

There are several filaments currently visible on the disc, one of which is particularly large (in the northeast quadrant) and needs to be monitored for any lift-off. This will become particularly relevant at the end of the forecast period, as this filament approaches the central meridian and faces Earth.

Solar activity is forecast to be Low to Moderate, with a decreasing risk as AR3376 rotates further away from the horizon (onto the far side). However, helioseismology suggests an increase in the number of regions expected to rotate onto the visible disc, which could lead to an increase of the probabilities over the following days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	55	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: Latest X-ray flare activity, as observed by GOES-16

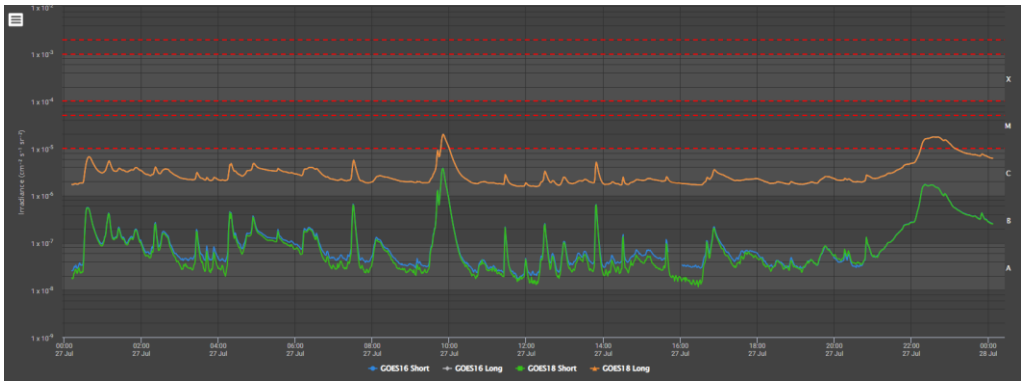

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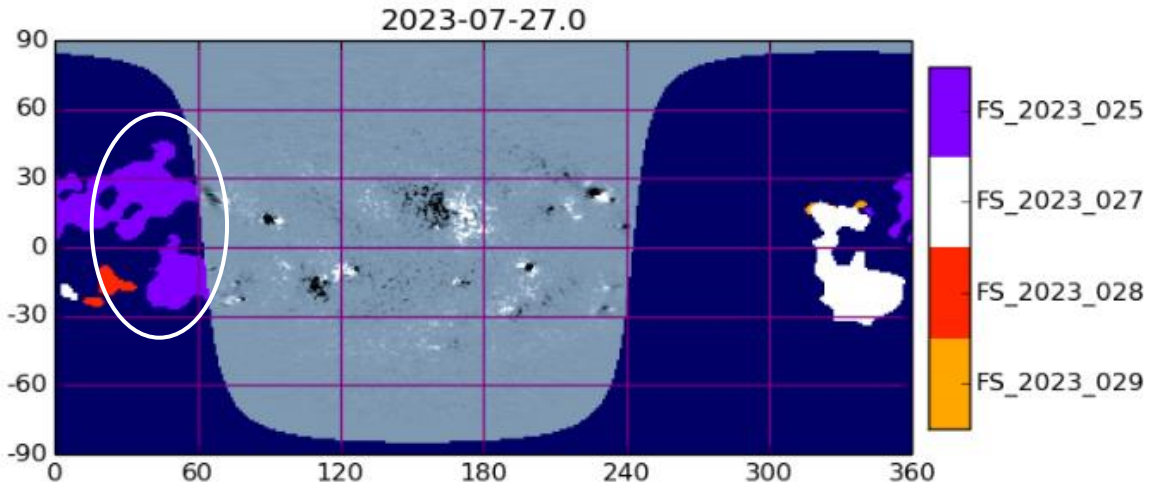
Figure 3: Stanford University helioseismology, with additional regions (circled) due to rotate onto the visible disc in the next two days.



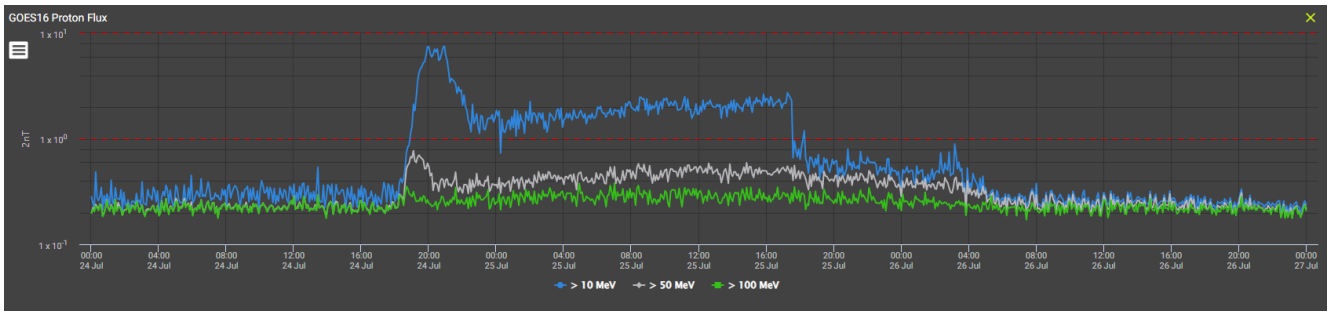
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is at background levels and expected to remain so throughout the period. However there is a daily slight chance of reaching the S1 / Minor Storm threshold given the number and complexity of some sunspot regions, notably AR3376 which has been responsible for a slight enhancement on the 24 & 25 July. The probability reduces somewhat on Day 2 as AR3376 rotates further away from the horizon (onto the far side).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Slight enhancement observed on 24 & 25 July, as seen by GOES-16



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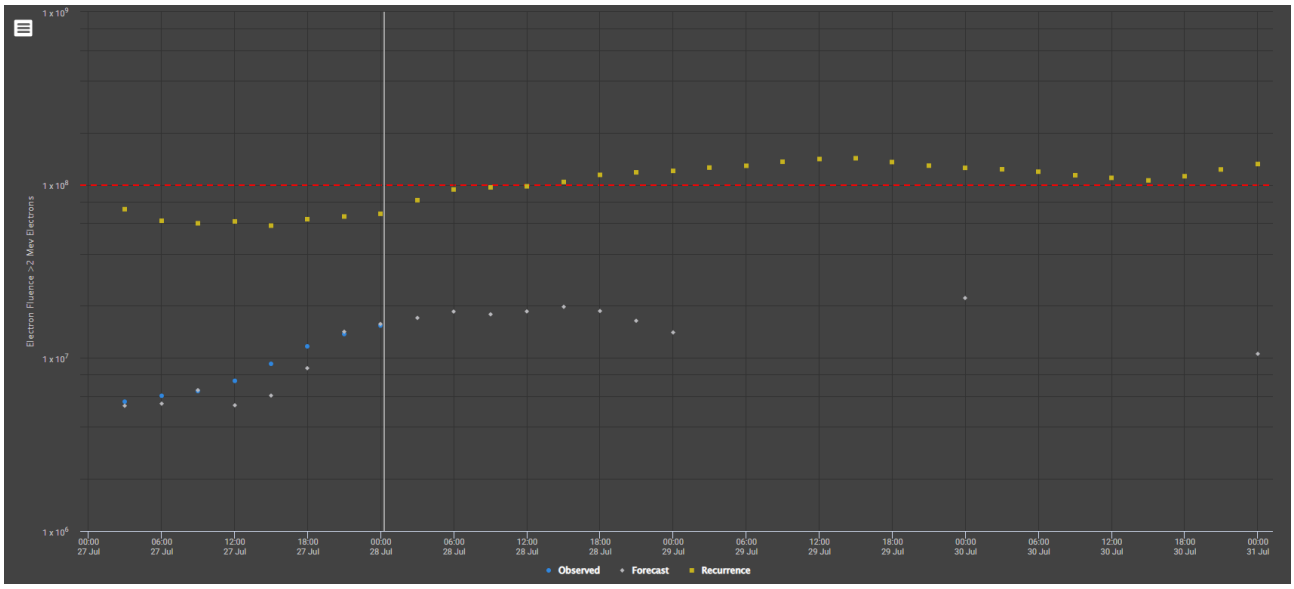
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) levels have recently begin to increase modestly during the diurnal peak, following the subsidence in activity associated with the CME that arrived on 25 Jul. However the G1 (Minor Storm) observed during the early UTC hours of the 26 July may have contributed to a little reduction in the quantity of electrons in the radiation belts.

The only feature likely to replenish them is CH28 but it is most likely too small and its associated HSS too weak to sustain a strong and constant feed of electrons. In other words, they may increase and reach high levels during the diurnal peak over the following days but the associated electron fluence is most likely to remain below the Active (1e8 integrated pfu) threshold.

The latest REFM output is considered to give good guidance on this occasion.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Latest REFM output, considered to provide good guidance



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